HURON MOUNTAIN WILDLIFE
FOUNDATION

Summer 2016
Newsletter

Unpacking Secrets of Ancient Earth At Canyon Lake

By Jill Riddell

On a warm June morning, the flat-bottomed rowboat that resides at Canyon Lake is packed so full of science equipment you can barely see the boat's floor. There are sensors to measure light and pigment levels, reels of plastic tubing for water sampling, and dry ice to keep samples cold. Four scientists are ready to venture out onto the lake, but the little boat has space left for only two. It's Sergei Katsev's and Nick Lambrecht's turn, (from University of Minnesota Duluth and Iowa State University, respectively) so the men step into the boat, find spots to sit among the gear, and push off.

Chad Wittkop (Minnesota State University-Mankato) and Betsy Swanner (Iowa State University) watch them go. As the oars churn through the water, the dark lake sparkles. Sheer rock cliffs rise up along the lake's perimeter. Once the researchers-turned-rowers have moved out of sight, Wittkop and Swanner return to the cedar grove to swat black flies and chat about the work.

Wittkop was the first member of the research team to visit Canyon Lake. He'd sought it out in the summer of 2014 because he'd read about its remarkable features. "Canyon was unlike any other lake I've ever visited. I'd developed a level of anticipation, so it was an exciting day when I actually got out here and saw it for myself. Even if you don't know anything about the geology or microbiology, Canyon Lake already is fascinating. And its mystery is deepened by its unusual chemistry and connection to our planet's most ancient secrets."

While almost every other lake in the temperate zones of the world rotate water twice a year, with the water at the bottom

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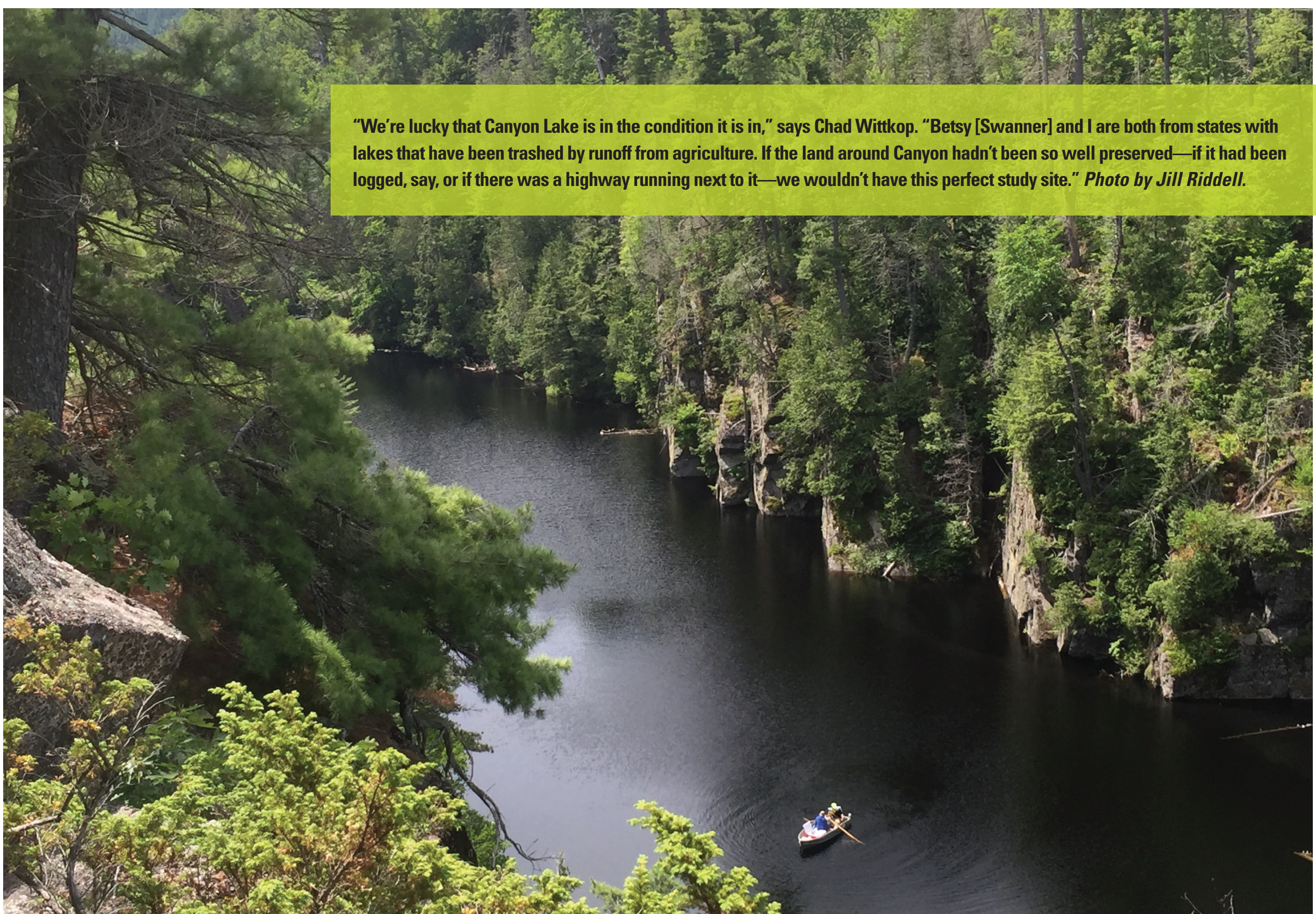


"We're lucky that Canyon Lake is in the condition it is in," says Chad Wittkop. "Betsy [Swanner] and I are both from states with lakes that have been trashed by runoff from agriculture. If the land around Canyon hadn't been so well preserved—if it had been logged, say, or if there was a highway running next to it—we wouldn't have this perfect study site." ***Photo by Jill Riddell.***

completely mixing with water at the top, that typical turnover never happens in Canyon Lake. The water currently resting at the bottom of Canyon Lake has been there for at least seventy years, and probably much longer. It's possible that the bottom two meters has been sitting there undisturbed and unchanged for millennia. "Only a portion of Canyon Lake's water mixes, and there's a deep layer that never mixes or is never observed to mix," Wittkop says. "Because of that, the water isn't exposed to the earth's atmosphere."

In 1940, there was a study of Canyon Lake done by Lloyd L. Smith, Jr., a professor at the University of Minnesota. *"Unusual chemical conditions exist throughout the year and give strong indication of permanent water stratification,"* Smith observed back then and when Wittkop discovered Smith's paper, it seemed this just might be the lake Wittkop had been looking for. Less than one percent of all lakes on earth—and possibly even fewer, maybe only one in a thousand—are permanently stratified.

Swanner explained that the research team's findings have already confirmed Smith's discovery. "At the surface, we measure 9 milligrams of oxygen per liter of water, which is normal, but by the time we get down to 14 meters, the oxygen level drops to .1 milligram per liter. At the very bottom, at twenty-two meters, the oxygen level is zero."

The absence of oxygen makes it possible to maintain high concentrations of dissolved iron in the water. This was also true of Earth's ancient oceans. When an atom of iron comes into contact with an atom of oxygen, the two rapidly meld into iron oxide which is not soluble, so it settles out. The two elements are so quick to combine that it's rare to have iron in a dissolved state.

"But Earth didn't come out of the box having oxygen," Wittkop says. "All the oxygen that we breathe and take for granted today is the product of photosynthesis. That's why when astrophysicists search for life on other planets, they look for evidence of oxygen. The only way to build up oxygen is for there to be organisms present that can manufacture it."

"Plants and algae drive the carbon cycle everywhere on earth," Swanner says. "But there are a few remaining places—like Canyon Lake—where it doesn't. We knew from the geological record that there was a carbon cycle going on in ancient times, well before plants and algae ever existed. So back then, there had to be some type of primitive system *creating* a carbon cycle. Some system that didn't produce oxygen as its waste product. It is possible that Canyon Lake retains a photosynthetic carbon cycle driven by iron, as on the early Earth."

For the researchers, being at Canyon Lake is like finding out that some creature you thought existed only as in the fossil record actually has a living, breathing relative that's still alive. At Canyon Lake, an ancient period of history that scientists knew existed because evidence of it appeared in stone suddenly becomes current, alive and real. What before was merely theoretical is now being experienced—and sampled and studied—firsthand in the Northwoods.

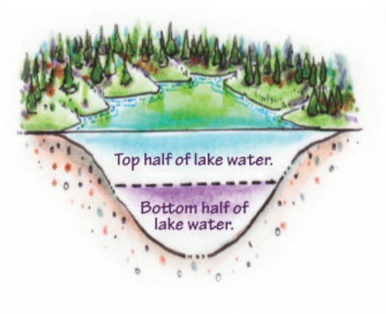
"Eventually, that primitive system driving the carbon cycle got out-competed by the system we know today, the one driven by plants and oxygen," says Swanner. "How did that happen? What was the older system like? What lived in that ancient ocean water? What was its geochemistry? These are the questions we're trying to answer."

The team's research will bring to science a clearer understanding of the large-scale planetary processes of the past and what impact that knowledge has for us today.

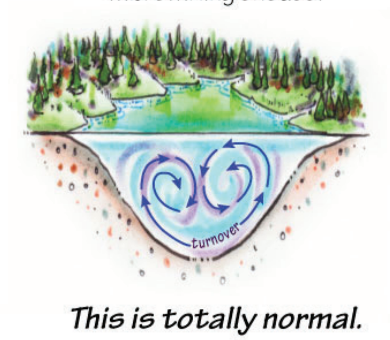
Betsy Swanner, Chad Wittkop, Nick Lambrecht, and Sergei Katsev are uncovering the secrets of Canyon Lake's geology and chemistry, and are looking for rare forms of microbial life that don't require oxygen. They will be applying for a National Science Foundation grant to continue their work. *Photos by Jill Riddell.*

Seasonal Lake Turnover & How Canyon Lake Differs

For one whole season, in either summer or winter the lake is stable.



During the change of seasons in fall and spring wild swirling ensues.



For the next whole season it's stable again, only now:

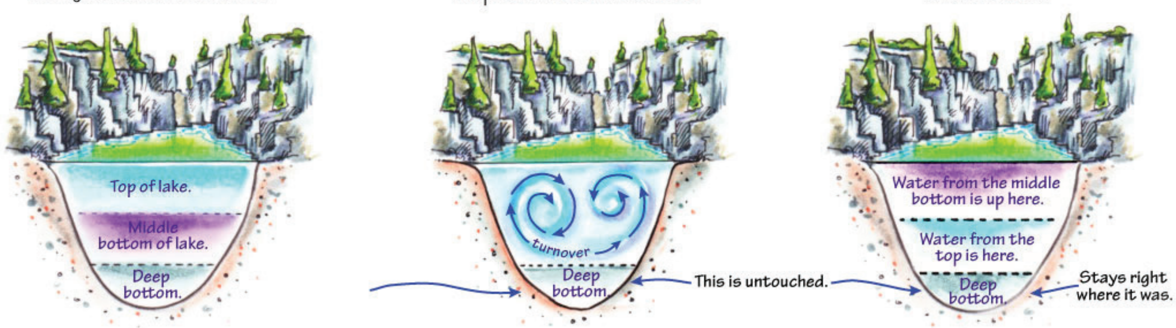
This is totally normal.

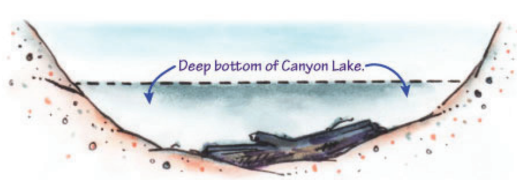
Pine Lake, for example, does this all the time, every year, two turnovers. But here's what happens (and what doesn't) at eccentric Canyon Lake:

Like other lakes in summer and winter Canyon Lake is stable.

But during the change of seasons, the turnover doesn't impact the entire lake.

The top 85 - 95% turns over, but the bottom 2 - 3 meters never does.





The bottom-most layer of water is intriguing. That liquid may have been resting there for decades or thousands of years. It's empty of oxygen and loaded with iron. Strange little organisms may live there that can't live anywhere else.

Illustrations by Lynda Wallis.

2016 Research Program

By Kerry Woods

The Huron Mountain Wildlife Foundation and its Ives Lake Research Station have attracted interesting new research this year, and the projects show an ever-increasing geographic and scientific scope. We have twenty-five projects happening this summer, conducted by researchers from more than twenty different institutions. It's particularly notable that a third of these studies are new this year, and several originate from universities new to the Foundation.

In these descriptions, I focus first on seven of the new projects, each of which points to some of the unique research values and opportunities afforded by the Huron Mt. landscape. Following that is the overview of ongoing projects.

ALL ARE INVITED TO THE ANNUAL MEETING

Tuesday, August 2, 2016
4:00 p.m.
At the Playhouse at the
Huron Mountain Club
Keynote Speaker: Chad Wittkop

New Projects

Dr. Christopher Anderson (Auburn University) is using the juxtaposition of old-growth and previously managed forests to assess effects of land-use on watershed drainage properties. Anderson maps small head-water streams (that are often not accurately represented by available maps) to develop GIS models to predict drainage location and density, and to ask whether differences in land-use history lead to different drainage patterns.

Two studies are using the remoteness and pristine nature of the Huron Mts. to assess the extent of human impact on ecosystems not directly economically exploited. **Dr. Gayle McGlynn** (Trinity College, Dublin – our first international project) will examine sediment cores from lakes looking for signatures from 19th-century industrial activities and large-scale logging in other parts of the Upper Peninsula. Understanding atmospheric transport of pollutants from mines and large-scale forest clearance will help establish true "baseline" conditions for regional aquatic ecosystems and can assess threats from current and future regional activities.

Dr. Stephen Techtmann (Michigan Technological University) will examine microbial communities in Huron Mt. streams for the presence of biocide-resistant microbes. Release of agricultural and industrial biocides (pesticides, antibiotics, etc.) into the environment has led to widespread evolution of resistant microbes, but it is not known whether these resistant varieties spread beyond habitats affected by the biocide. Almost nothing is known about how they might impact relatively pristine habitats. Techtmann's work will also provide a great deal of information about microbial communities and diversity in general.

A new faculty member at the University of Michigan, **Dr. Nyeema Harris,** is beginning a planned three-year study of ecological relations of "mesocarnivores" – carnivores ranging from skunks and raccoons to coyotes. Many of these species are wide-spread and abundant, but they are surprisingly poorly understood ecologically because of how difficult they are to follow and monitor. Harris's project will start by using an extensive network of autonomous cameras ("game cameras") to document abundance and behavior of mesocarnivore species.

A second mammal-focused project focuses on two co-occurring species of flying squirrels in the Huron Mts. **Dr. Cody Thompson** (also from the University of Michigan) will use genetic analyses (using hair from live-trapped squirrels) to assess whether the northern and southern species are hybridizing in the area. Earlier work at Huron Mt. (conducted by University of Michigan Professor Phil Myers) helped establish that the southern flying squirrel is expanding its range and population in the U.P.; because Lake Superior blocks migration of northern flying squirrels northward, increased contact between the two may result in hybridization and blurring of the distinctness of each species.

Dr. Amy Hessl and her graduate student, **Alex Dye** (West Virginia University) will use tree-ring records to reconstruct rates of wood production in Huron Mountain hemlock stands, using their results to fit long-term models of factors regulating forest productivity – the critical contribution to "carbon-sink strength." Hessl's study points to the range of collaborations growing from HMWF-sponsored research. Dye and Hessl will build their sampling around the long-term study plots established by Eric Bourdo in 1962 (and last measured in 2014); this 50+ year record will afford accuracy assessment for their tree-ring analyses and provide mortality data to support modeling of stand-level dynamics. In addition, Hessl is part of the PalEON project, a large, National Science Foundation-supported network of paleoecologists and modelers working to bridge scales of study between paleoecologists (who think in centuries and millennia) and "neo"-ecologists (working in years and decades). PalEON held a two-day field workshop at Ives Lake last summer, and I am excited to see that linkage continued.

Finally, **Dr. Carmen Greenwood** (State University of New York – Cobleskill) will be adding the Huron Mountains to her continent-scale study of burying beetle communities. Burying beetles (genus *Nicrophorus*) work in pairs to bury (up to 8 inches deep) corpses of small animals, coating them with decay-inhibiting secretions, and laying eggs on the buried carcass. The adult pair has a habit that's extremely unusual for insects: they remain with and tend the developing larvae. There are several dozen species of *Nicrophorus* (six have been documented at HMC by past HMWF researchers), but the American burying beetle *(Nicrophorus americana)* – federally listed as an endangered species – has not been documented, and the area is near its northern range limit. Greenwood and her collaborators hope to use better general understanding of burying beetle communities and ecology to inform recovery plans, which include possible active reintroductions. Their work is supported by a grant from the U.S. Fish and Wildlife Service.

These new projects provide a sense of the scope of HMWF-supported research, and of the appeal of the Huron Mts. landscape and the Ives Lake Research Station to researchers. HMWF offers research opportunities of national and international significance, and the research grants enabled by contributions to HMWF catalyze the majority of our research projects in their initial phases (most ultimately transition to other sources of funding).

Continuing Projects

The list of returning and continuing researchers emphasizes these points and the unique potential for the Huron Mountains "reference ecosystems" to support long-term studies critical to understanding natural systems and the effects of environmental change. Here is a summary of the rest of the 2016 research program.

Jim Bess (Hancock, MI), **Dr. Thomas Werner** (Michigan Technological University), and **Patrick Gorring** (Harvard University) are all continuing to inventory the biodiversity of important insect groups. Werner and Bess have been surveying *Lepidoptera* (moths and butterflies) since 2014, and have added about 500 species to the general biodiversity inventory of HMC lands. Werner is also studying fruit flies, and Bess is inventorying "leafhoppers" with a focus on habitat specialists of barrens and granite bald habitats. Gorring is expanding from his past studies of wood-boring beetles to survey the very large and poorly documented weevil family. **Dr. Mark Wetzel** (Illinois Natural History Survey) will be adding to his several years' study of aquatic and terrestrial annelid worm diversity.

Research in aquatic systems includes **Dr. David Costello's** (Kent State University) continuing analysis of the role of "biofilms" of micro-organisms in ecosystem processes in the Salmon Trout River, with particular focus on how these communities are affected by trace metals.

Chad Wittkop (Minnesota State University – Mankat) and collaborators from several other universities will be expanding their research on the unusual biogeochemistry of Canyon Lake.

Dr. Donna Kashian (Wayne State University) and colleagues will maintain their long-term monitoring of macroinvertebrate communities in several streams in the region, and **Dr. Scott Tiegs** (Oakland University) continues his parallel long-term monitoring of decomposer activity in regional streams.

The unique old-growth forests of the Huron Mts. host several long-term studies in addition to the newly initiated projects already listed. Two continuing studies focus on the effects of abundant deer on forest ecosystem processes. **Dr. Don Waller** (University of Wisconsin) and collaborators continue to monitor the effects of excluding deer browse in the large "exclosure" near Fisher Creek (now in its sixth year), and **Dr. Rose-Marie Muzika** (University of Missouri) and **Dr. Walter Carson** (Pittsburgh University) will begin monitoring small "deer-cages" near Howe Lake (constructed last year) to explore the limits on recolonization by forest understory plants adversely affected by deer. **Dr. Dennis Riege** (University of Maryland) is maintaining his decade-long study of white pine and hemlock regeneration in old-growth stands near Fisher Creek, supplementing this with an opportunistic study of the effects of beaver activity in one of his permanent study plots. **Dr. Greg Corace** (U.S. Fish and Wildlife Service) will be in the final planned year of a study of plant and bird communities in response to management in jack pine stands.

Several researchers are also maintaining intensive studies of particular plant populations and species. **Dr. Evelyn Williams** (Chicago Botanical Garden) is continuing long-term studies of population dynamics of the mysterious "grape-ferns" (genus *Botrychium*). **Dr. Jalene LaMontagne** (DePaul University) is in the fifth year of monitoring and modeling production of cones and seeds – an important food source for many birds and mammals – in white spruce populations. In the latest phase of his wide-ranging research on oak populations, **Dr. Oliver Gailing** (Michigan Technological University) is using genetic tools to understand seed dispersal in red oaks, using Huron Mt. populations as an "old-growth" reference baseline.

Finally, **Dr. Fritz Nelson** (Northern Michigan University) and **Dr. Ken Hinkel** (University of Cincinnati) are maintaining their long-term microclimate monitoring network and supplementing it with studies of the thermal budget of HMC lakes. In addition to original contributions to understanding of fine-scale climate variation in response to Lake Superior and the complex terrain of the Hurons, this project provides invaluable data sets for many other researchers.

A New Emphasis

The contribution of the Nelson-Hinkel microclimate network and database to other studies illustrates an important trend that we hope to emphasize and magnify in coming years. Over the last decade, much of the most exciting and valuable ecological research has built upon integrative "meta-analysis" of multiple, often long-term data-sets. Such approaches are critical to understand the behavior of complex systems in a changing world and for steering management and conservation policies. Recognizing this, research agencies and funders are emphasizing the importance of securely archiving data and making data sets accessible to other researchers.

The Foundation has long encouraged collaboration among researchers and projects and, every year, we see several projects that build on and complement previous research. However, since we lack the infrastructure and personnel to maintain data archives and to actively coordinate research initiatives, we have had to rely, largely, on the willingness and initiative of researchers to propose and pursue such collaborations. Now, driven by the emphasis of major funders and agencies on data archiving and sharing, well-maintained, public data repositories are springing up (for example, DataONE – www.dataone.org – and the Knowledge Network for Biodiversity – knb.ecoinformatics.org). Beginning this year, HMWF will be requiring all researchers, after an appropriate "exclusive-use" period for developing their own publications, to deposit data in one of these archives. Moving forward, we may be able to incorporate a gateway to these data-sets in our own webpage but, in the meantime, we will insure the long-term persistence and availability of the results of Foundation-supported research.

DONATIONS WELCOME

You can make a donation by mailing a check made out to "Huron Mountain Wildlife Foundation" to:
Treasurer, Huron Mt. Wildlife Foundation,
5075 Warren Road, Ann Arbor, MI 48105

HMWF is a 501(C)(3) organization and donations are fully deductible.

Growth Rings Reveal History: A Hemlock's Tale

In this hemlock that lived on Mummy Mountain, a series of tightly-spaced rings indicate a period of very slow growth when the young tree was overshadowed by taller trees. After that come broader rings showing rapid growth. It's likely that a nearby canopy tree died and allowed more light to reach the struggling young sapling. There were at least two such "releases" before this tree finally made it to the canopy itself. By then, it was 75 years old.

Reaching the canopy offers a tree the advantage of permanent and reliable availability of light so after that, the hemlock's growth rate stepped up, becoming ten times faster. Although large trees still experience stresses and insults, this rate of rapid increase typically lasts for a number of decades, as it did for this one. But eventually, just a tree's being so enormous and approaching the size limit for its species inevitably leads to slower growth. The hemlock's rings demonstrate this, with widths during the last 200 years of its life becoming as close together as the earliest rings. In the last half of its life, the mature hemlock's girth increased by less than one inch per decade.

Over the long term, the diminishing rate of growth in a large tree is an indicator that it's slowly failing. Yet trees can spend more years in a stage we call "dying" than the total number of years a human can spend living.

Photo and text by Kerry Woods

Above: When trail crews cut apart fallen trunks that obstruct pathways, what remains can be quite interesting. This tree was about 400 years old, and was "born" well before any European ever set eyes on Lake Superior.

About the Huron Mountain Wildlife Foundation: Since 1955, the Huron Mountain Wildlife Foundation has supported original research in a wide variety of scientific fields. The research takes place in the Upper Peninsula of Michigan. More information on the Foundation can be found at: **www.hmwf.org**

We welcome comments and suggestions on this newsletter. Please send them to:
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